

Tuesday 27th May – Frequency Excursion Great Britain

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Agenda

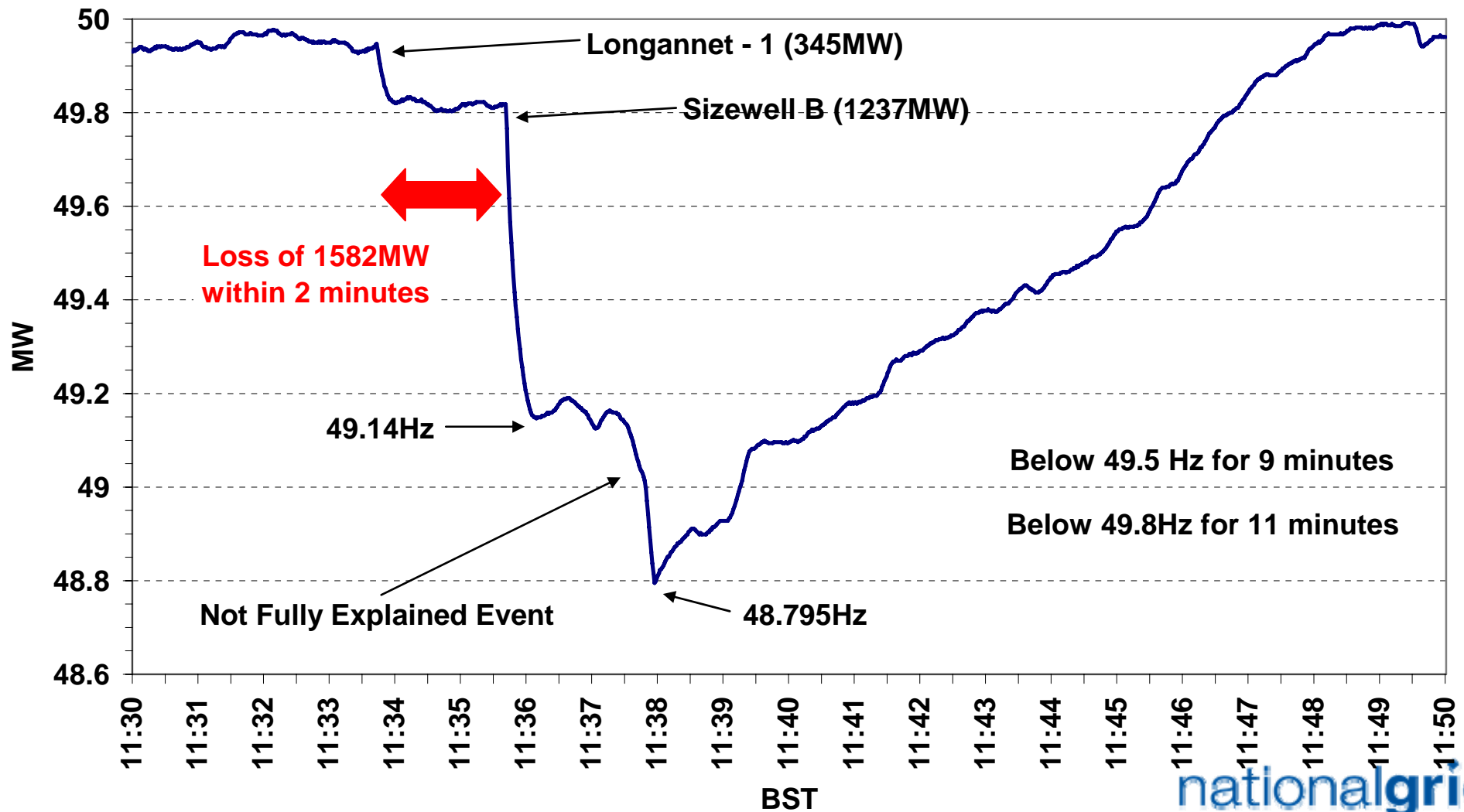
- ◆ Introduction
- ◆ Overview of Security Standards
- ◆ Response Holding & Margins
- ◆ Time Line of Events
- ◆ Frequency Response Performance
- ◆ Post Event

Introduction

- ◆ GB Peak Demand (winter) ~ 66GW
- ◆ 27 May 08 - Exceptional Loss of 1582MW within 2 minutes
 - ◆ 11:34am – Loss of Longannet (345MW)
 - ◆ 11:36am – Loss of Sizewell B (1237MW)
- ◆ Frequency
 - ◆ Initial Frequency drop to 49.14Hz
 - ◆ Lowest recorded point = 48.795Hz
 - ◆ 581MW of automatic low frequency demand control
 - ◆ Below 49.5Hz for 9 minutes
 - ◆ Outside operational limits (49.8Hz) for 11 minutes

Overview

27th May 2008 - Overview



Security Standards

- ◆ GB Normal Infeed Loss Risk

- ◆ Loss of **1000MW** covered over long periods by frequency response to avoid a deviation of system frequency by more than 0.5Hz.

- ◆ GB Infrequent Infeed Loss Risk

- ◆ Loss of **1320MW** covered over long periods by frequency response to avoid a deviation of system frequency outside the range 49.5Hz to 50.5Hz for more than 60 seconds.

- ◆ Post event

- ◆ measures shall be taken to re-secure the system to the above operational criteria as soon as reasonably practicable.

<http://www.nationalgrid.com/uk/Electricity/Codes/gbsqsscode/>

Security Standards - application

- ◆ For any credible fault of 300MW to 1000MW frequency shall not deviation not more than 0.5Hz (**Significant**)
- ◆ For any credible fault of 1000MW to 1320MW frequency deviation not more than 0.8Hz (**Abnormal**)
- ◆ For a significant or abnormal event any deviation below 49.5Hz should not persist for more than 60s and should return to operational limits within 10mins.
- ◆ Operational Limits defined as 50Hz +/- 0.2Hz

Security Standards - application

- ◆ A loss greater than 1320MW is “**Exceptional**” and frequency is protected by Demand Control
- ◆ A national Low Frequency Demand Disconnection (LFDD) scheme automatically disconnects demand to contain any incident and prevent a total or partial shutdown

Demand Control

- ◆ Automatic Low Frequency Disconnection
 - ◆ 60% of demand on Low Frequency settings 48.8Hz to 47.8Hz
 - ◆ Discrete blocks – first 5% at 48.8Hz
 - ◆ Reconnect instructed by NG
- ◆ Demand control on Instruction
 - ◆ Generally achieved by voltage reduction

<http://www.nationalgrid.com/uk/Electricity/Codes/gridcode/gridcodedocs>

Recap

- ◆ Frequency standards highlighted
 - ◆ Significant loss (300MW to 1000MW)
 - ◆ Abnormal loss(1000MW to 1320MW)
 - ◆ Exceptional loss– anything greater than 1320MW
- ◆ After a loss, recover response as soon as reasonably practical.

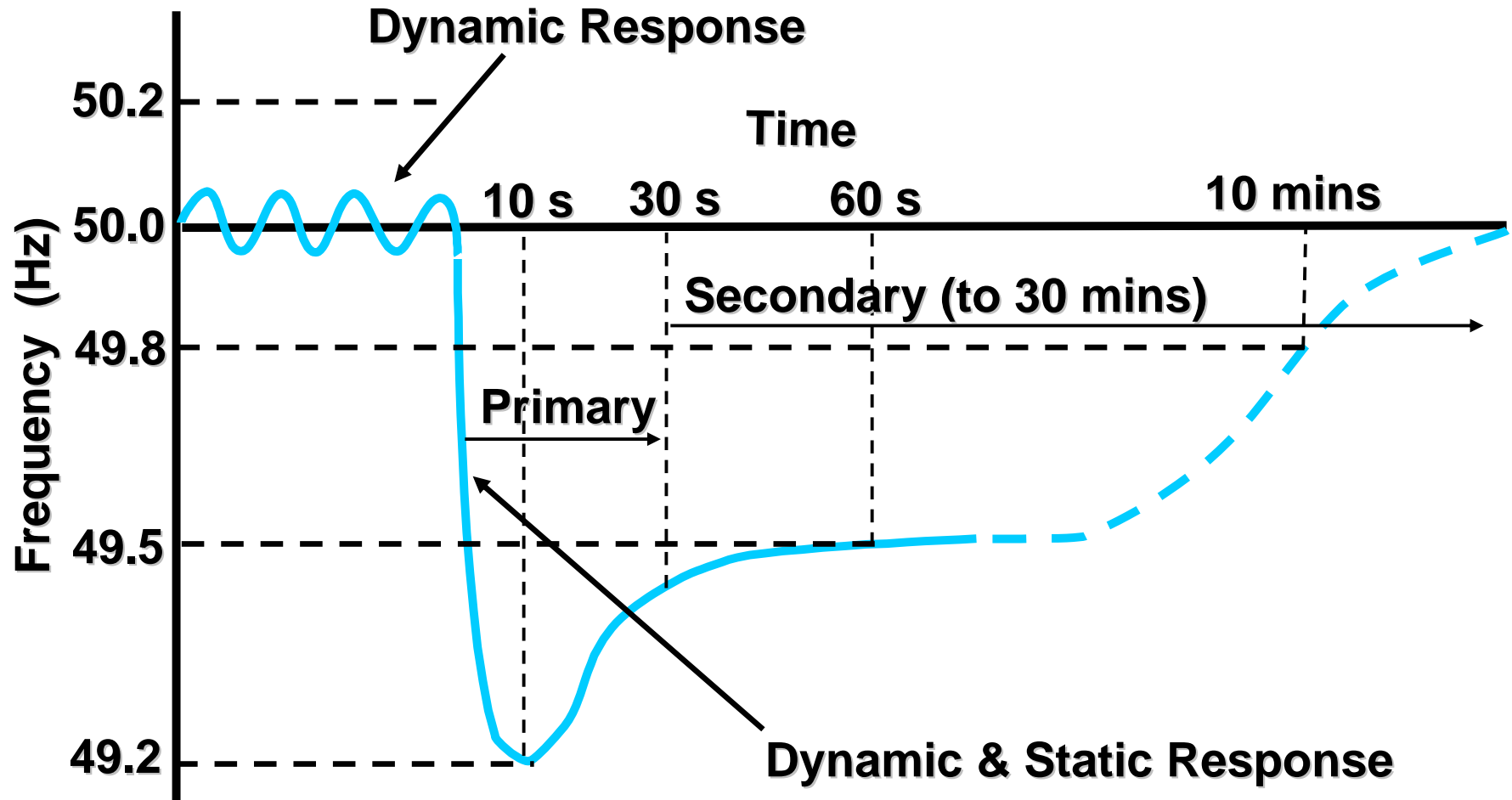
Response Requirement

- ◆ Carry response for maximum loss
 - ◆ Requirement varies with demand
 - ◆ Dynamic Requirement varies (450MW at time of trips)
 - ◆ Requirement met via Dynamic & Static providers
- ◆ Dynamic Response carried on part-load generation
 - ◆ Firm Frequency Response Providers
 - ◆ Remainder sourced on the day (economic dispatch)
- ◆ Static Response – Low Frequency initiated response
 - ◆ Demand side (range of providers of various sizes)
 - ◆ Interconnectors (reciprocal service)

Response Requirement

- ◆ Primary Response:
 - ◆ Automatic increase in active power output
 - ◆ Released increasingly over the period 0-10 secs
 - ◆ Fully available by $t = 10$ secs
 - ◆ Sustainable for a further 20 secs
- ◆ Secondary response:
 - ◆ Automatic change in active power output
 - ◆ Fully available from $t = 30$ secs
 - ◆ Sustainable for at least a further 30 minutes
- ◆ *delivery must be in accordance with provisions of relevant Agreements*

Largest Loss Frequency change



Response Provision on the 27th May

- ◆ Dynamic – output varying with frequency
 - ◆ Part-loaded BMU's
 - ◆ Firm Frequency Response Providers
- ◆ Static – only initiates for losses that go outside operational limits
 - ◆ Demand Providers on LF
 - ◆ Interconnector on LF
 - ◆ Pumped Storage BMU on LF

Requirement
(100%)

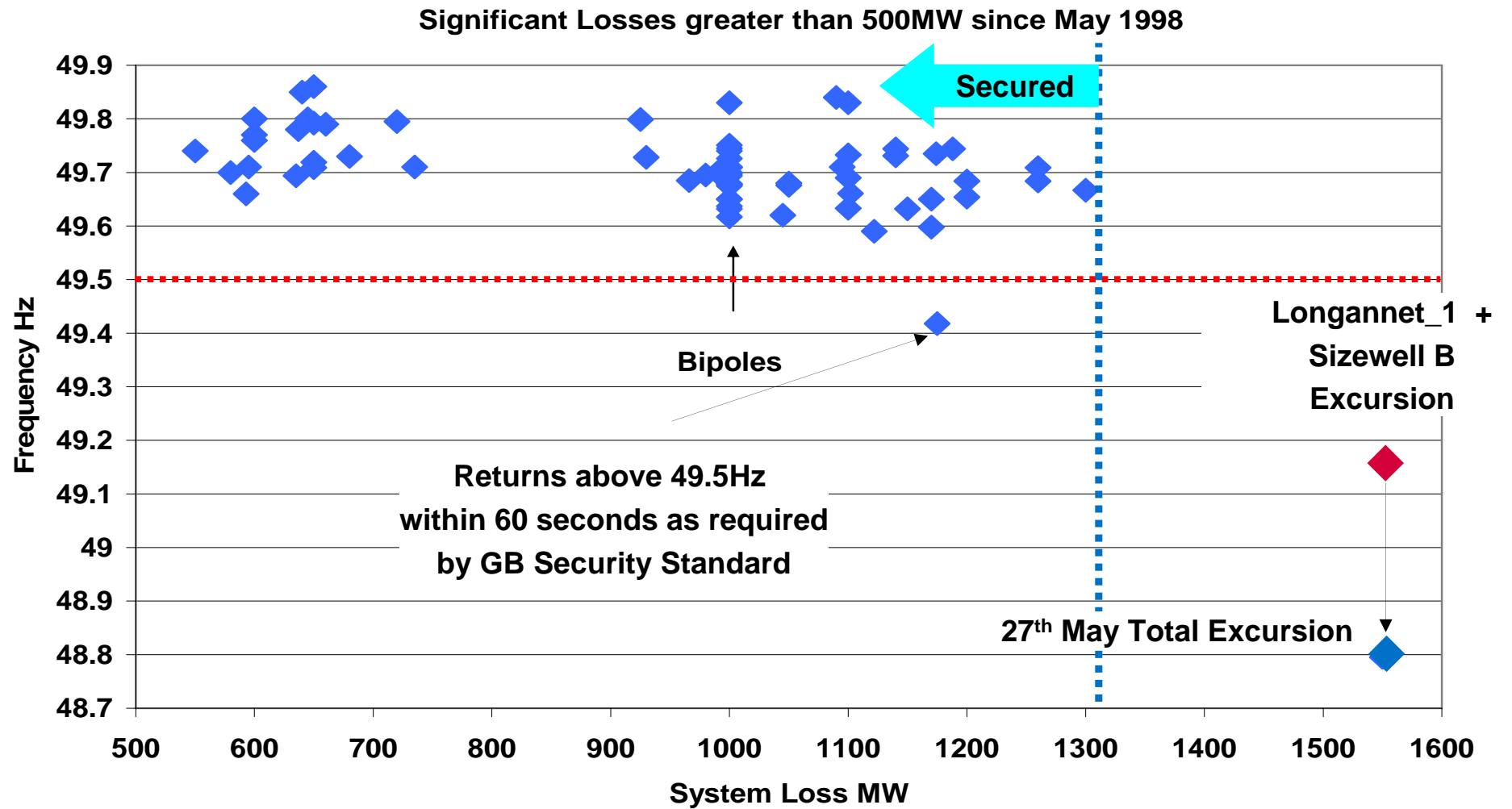
Dynamic
(~50%)

Static
(~50%)

Largest Loss Frequency change

- ◆ Following an Abnormal Loss
 - ◆ Return to Statutory Limits (49.5Hz) in 60 seconds
 - ◆ Return to Operational Limits (49.8Hz) in 10 minutes
 - ◆ Recover response for next largest loss in 20 minutes
- ◆ Historical Frequency deviations

Historical Frequency Deviations



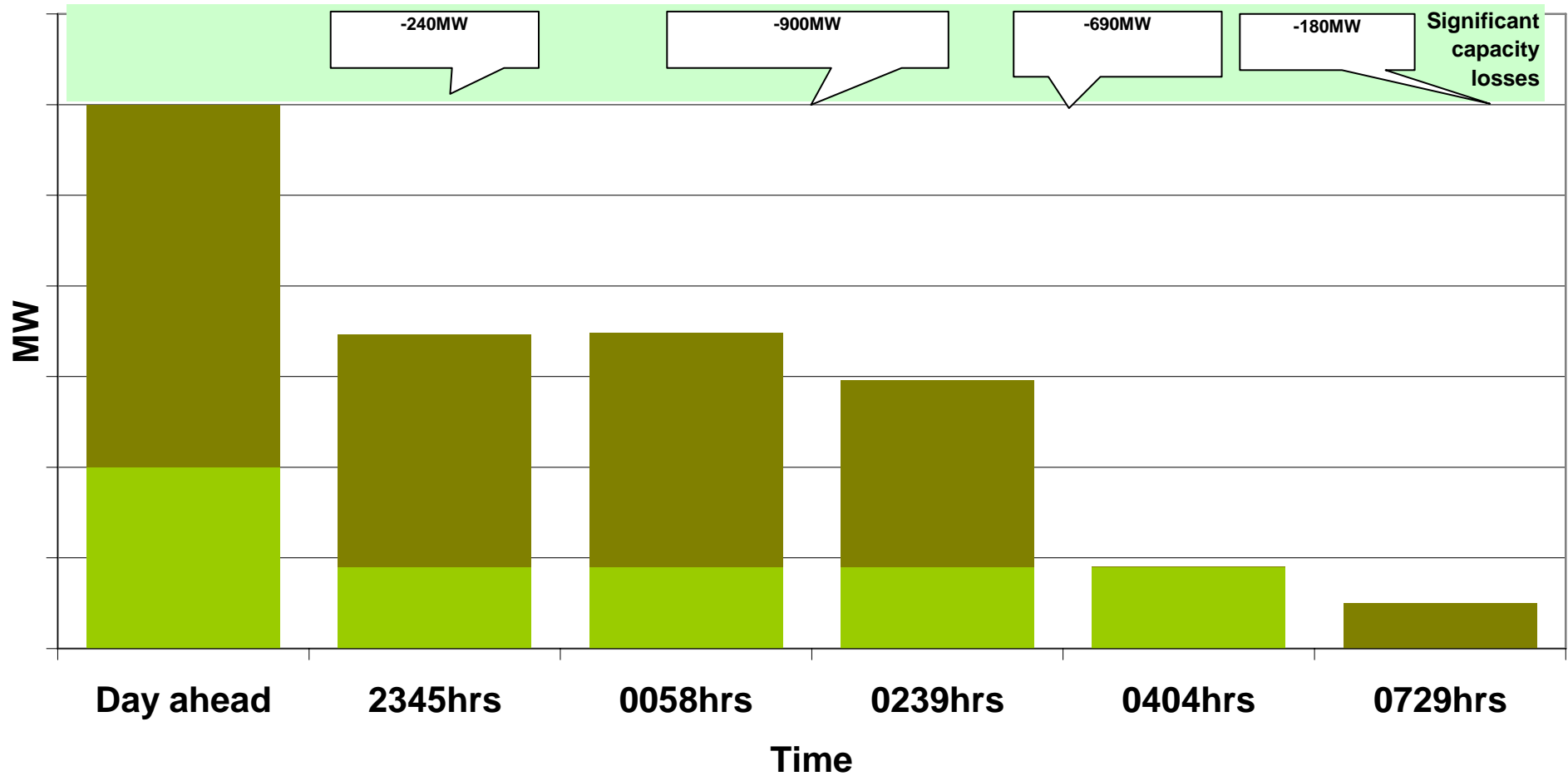
Recap

- ◆ On morning of 27th May
 - ◆ Response being carried by both Static and Dynamic providers as normal
 - ◆ Sizewell loss being covered
 - ◆ Dynamic Requirement = 450MW at time of trip

- ◆ Time line of events

Margins

Sufficient Contingency available leading up to Lunchtime Peak Demand

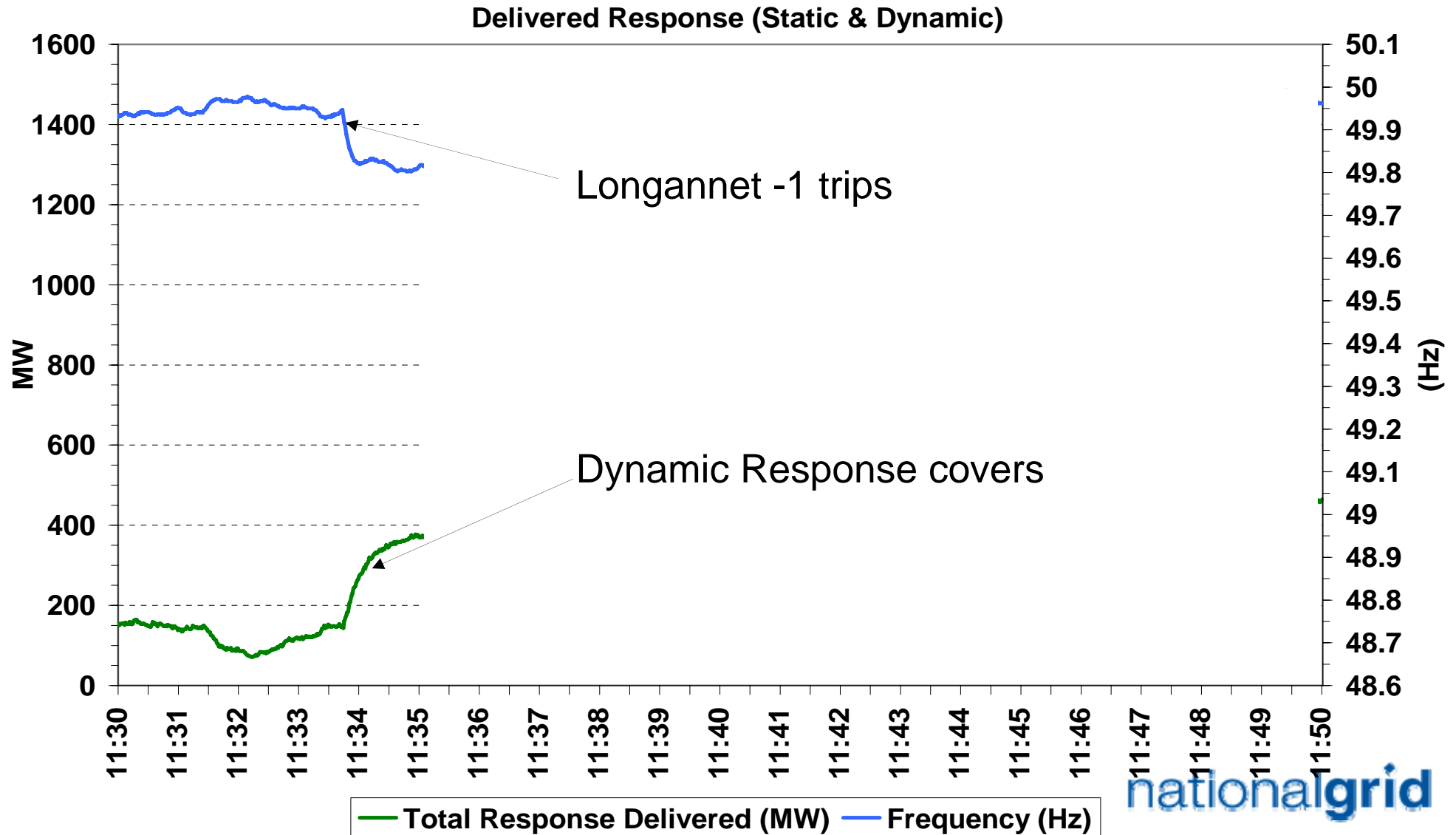


■ Contingency Reqt. ■ Plant in timescale

Margins

- ◆ Healthy Margins in run-up to event
- ◆ Sufficient plant available to meet Reserve requirement
 - ◆ No requirement to issue System Warning
- ◆ Losses in the morning run-up
 - ◆ 07:45 - 10:49 hrs
 - 300MW, 180MW & 760MW lost due to generator redeclarations
- ◆ Control Room responses:
 - ◆ 08:54hrs 370MW of Short Term Reserve initiated
 - ◆ 09:55 - 10:25hrs 2x 485MW generation instructed to synch
 - ◆ Final 100MW of French Interconnector capacity purchased

Longannet trip (11:34)

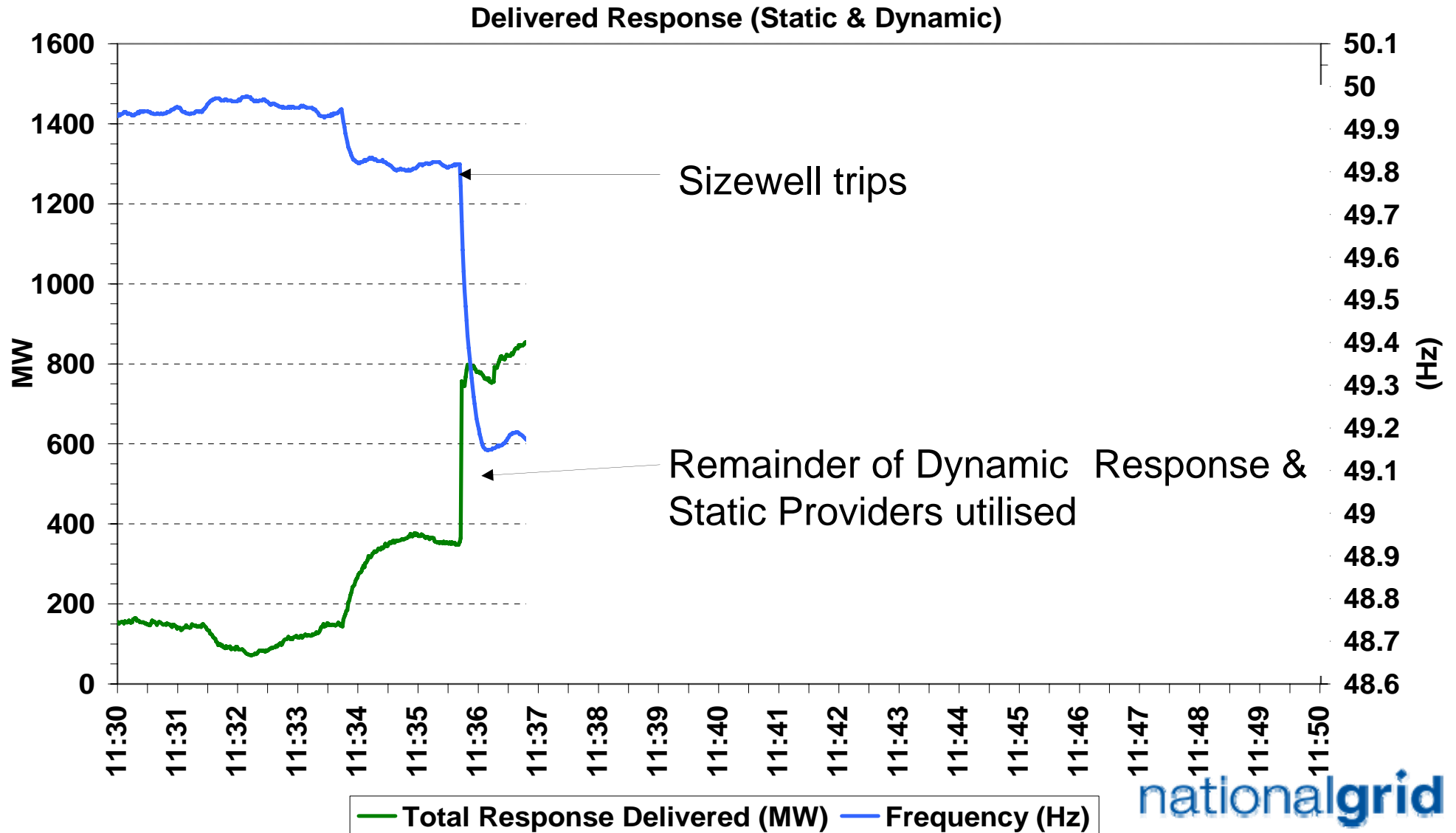


Longannet trip (11:34hrs)

- ◆ Loss = 345MW (running up to full load of 600MW)
- ◆ Normal Infeed Loss – deviation to be within 0.5Hz
- ◆ Actual Frequency deviation = 0.127Hz
- ◆ Contained within Operational Limits

- ◆ Control Room actions
 - ◆ Additional generation of 320MW instructed at 11:35hrs

Sizewell trip 11:36hrs

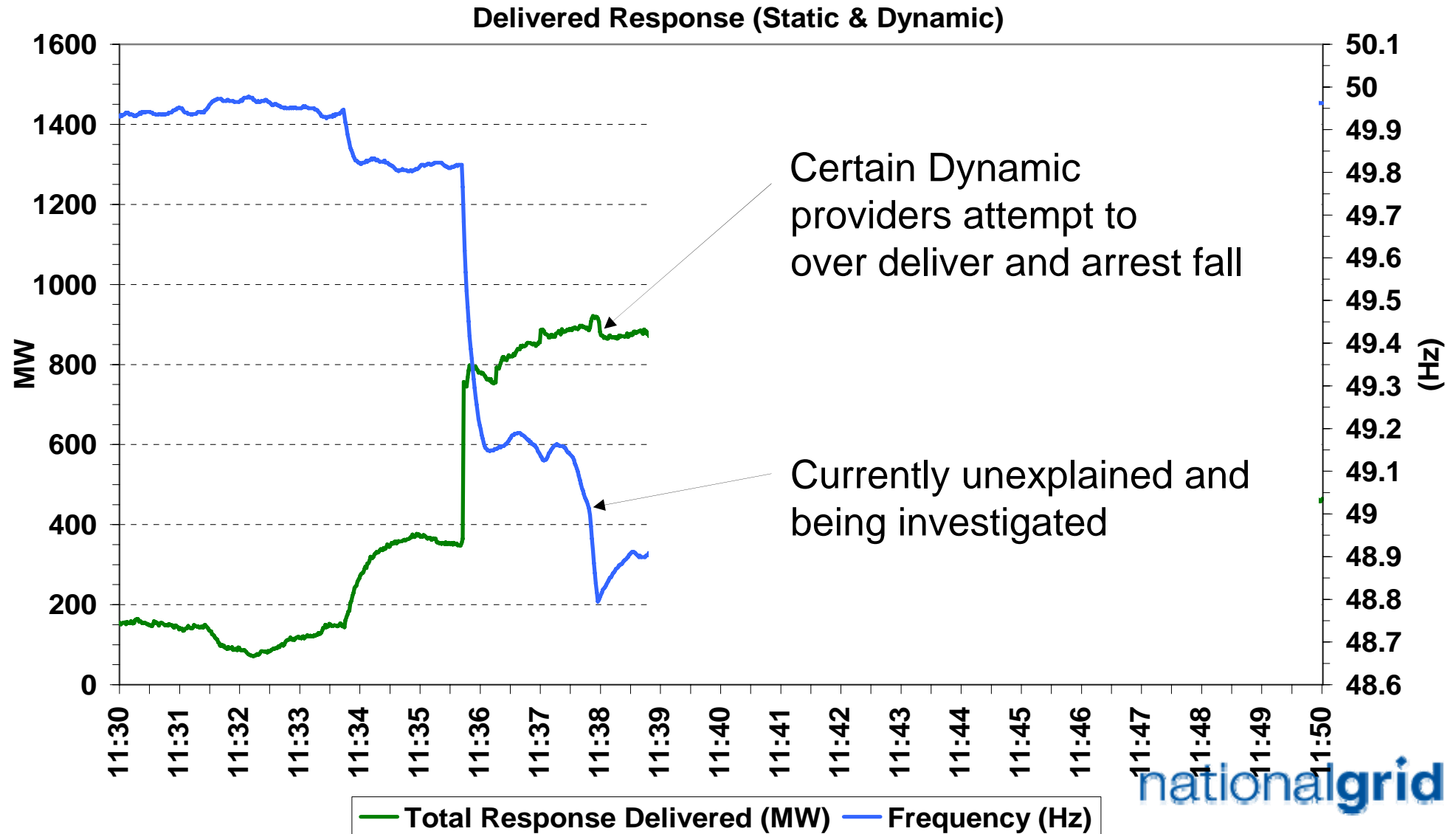


Sizewell Trip 11:36hrs

- ◆ Loss = 1237MW
- ◆ Abnormal Loss – deviation to be within 0.8Hz
- ◆ Actual Frequency deviation = 0.671Hz
- ◆ Frequency falls to 49.14Hz
- ◆ OCGT's on LF settings of 49.6 / 49.5Hz initiate

- ◆ Control Room actions
 - ◆ Additional Short Term Reserve instructed (~1000MW)

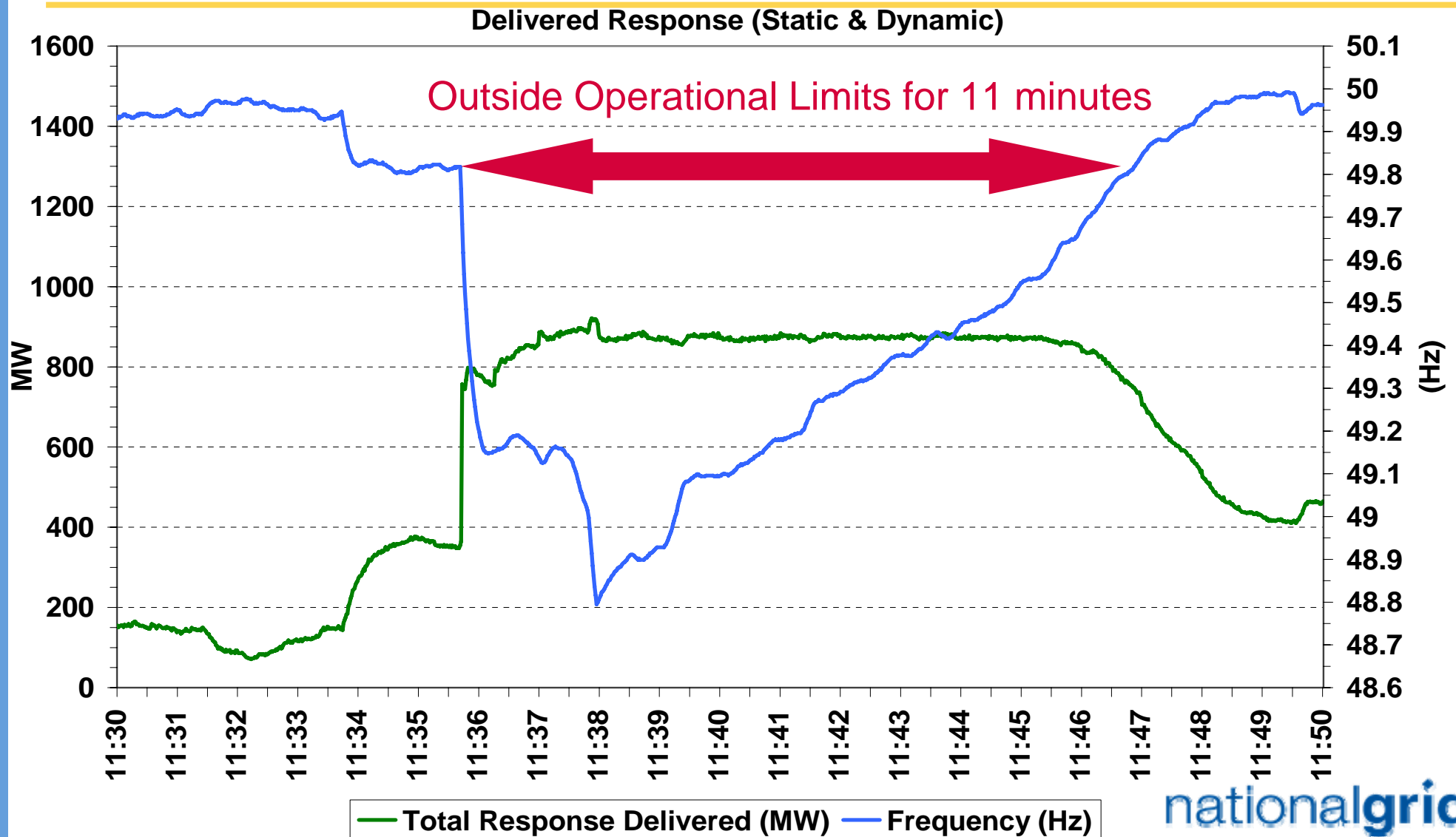
11:37hrs +



11:37 hrs +

- ◆ Further Loss
 - ◆ System frequency drops to 48.795HZ
 - ◆ Certain Dynamic providers respond to drop and deliver above their obligations
- ◆ Low Frequency Demand Disconnection (LFDD) triggered at 48.8Hz
 - ◆ 581MW of demand automatically disconnected (~600,000 customers)

Recovery



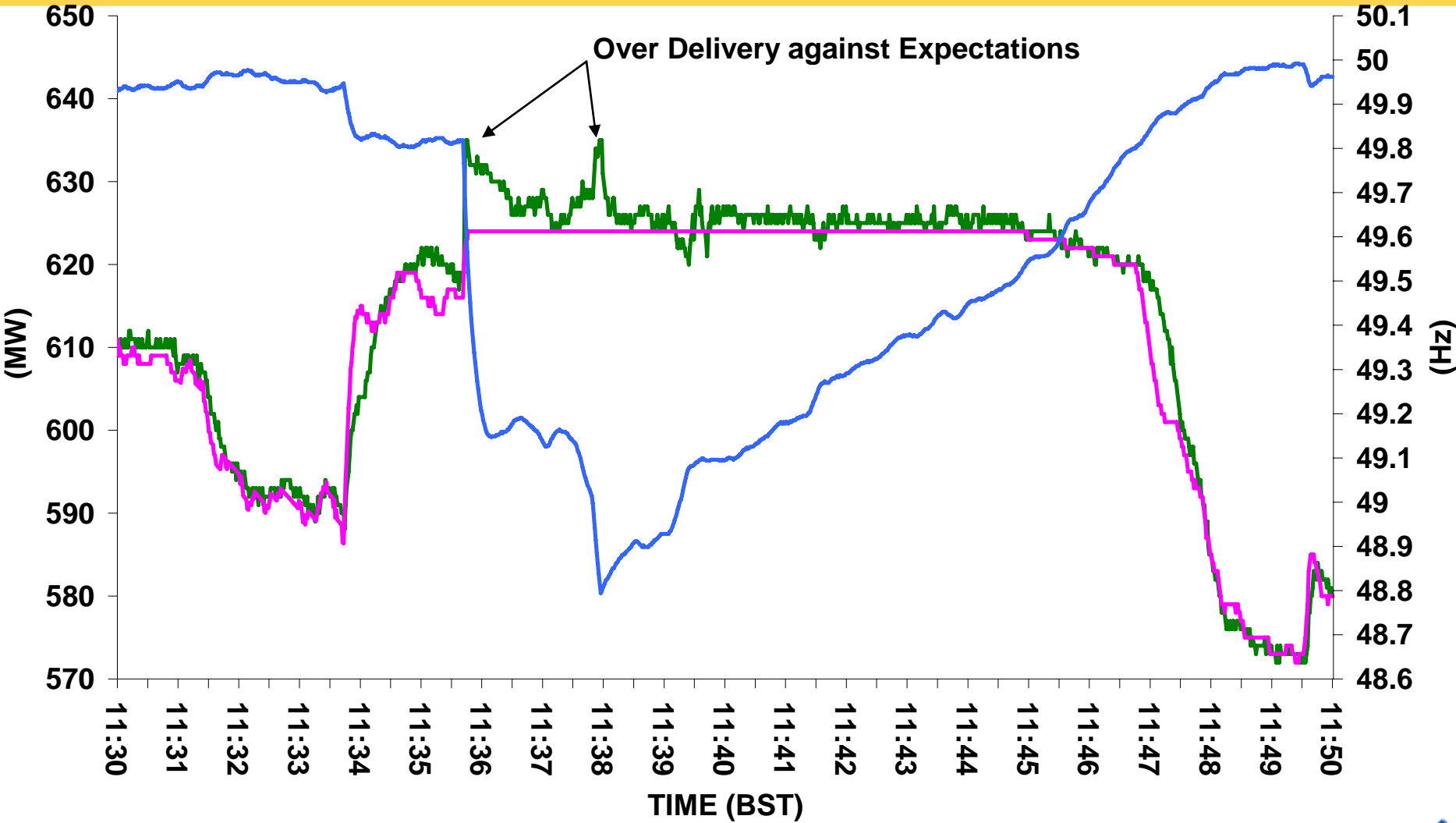
Summary of Recovery

- ◆ Control Room action as frequency reaches 48.8Hz:
 - ◆ 1200MW of Demand Control by Voltage Reduction
- ◆ Frequency Recovers
 - ◆ Outside Operational Limits for 11 minutes
 - ◆ Control Room manage recovery to avoid high frequency
 - ◆ Response recovered in 15 minutes to secure next largest loss
 - ◆ Within 40 minutes – disconnected demand restored

Overview of Dynamic / Static Providers

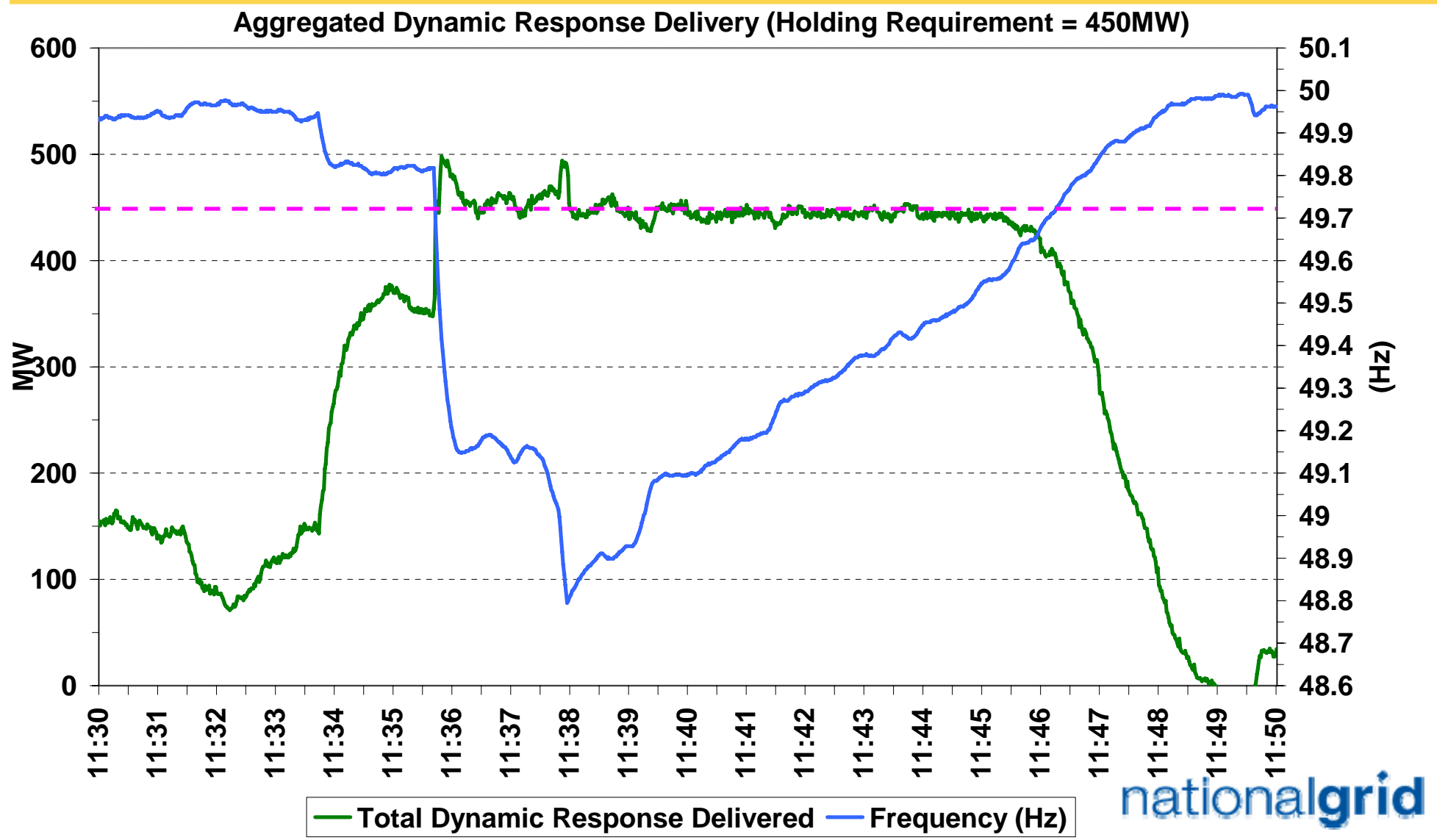
- ◆ Good primary performance
 - ◆ Initial deviations kept within limits
- ◆ Secondary performance within expectations
 - ◆ >100% delivery from Fast Response provider
 - ◆ Dynamic response of 450MW delivered
 - ◆ Under delivery from a few providers
- ◆ A number of generators not selected for response, become frequency sensitive at 49.5Hz and delivered.

Typical Response Provider



— GENSET OUTPUT — EXPECTED RESPONSE (MW) — FREQUENCY

Overview of Response Providers



Summary

- ◆ Loss of Longannet followed within 2 minutes by Sizewell was “exceptional”
- ◆ The major system disturbance / generation loss pattern represented a significant challenge
- ◆ Follow up examination of third frequency step from 49.14Hz to 48.8Hz in progress with
- ◆ Additional examination of:
 - ◆ performance of embedded generation
 - ◆ performance of Low Frequency Demand Disconnection Scheme
 - ◆ actual demand relief delivered by manually instructed Demand Control

◆ Questions